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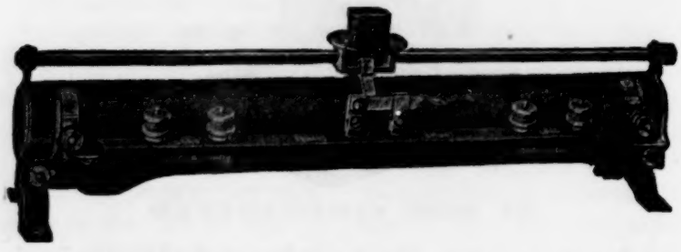

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SCIENCE

FRIDAY, APRIL 23, 1920

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PLATINUM AND THE METALS OF THE PLATINUM GROUP

WHAT promises to be the most complete and authoritative work on platinum and platinum deposits is about to be published in Geneva, Switzerland. The author, Louis Duparc, is professor of chemistry and petrology in the University of Geneva; the name of Marguerite N. Tikonovitch is announced as that of the associate author.[1]

Professor Duparc has long been known as the writer of many papers on the great platinum deposits of the Ural region in Russia, of which he has made special study. He has also investigated personally the notable platinum deposits in other parts of the world, and he gives in the present work the ripe results of more than twenty years investigation of the sources of this rare metal.

The first chapter will be devoted to the topography and geological aspects of the Ural region. This is followed by a chapter treating of the "mother rocks" of platinum, and by others on the petrography of the primary platiniferous centers, the dunites and peridotites. Then, in turn, are offered considerations on the pyroxenites and koswites, the rocks of the gabbro family and various vein rocks. The view is then extended to cover the metamorphosic rocks accompanying the eruptive platiniferous zone.

Turning then to what more immediately concerns the metal itself, the constituent elements of native platinum are studied, and its state in the different primary deposits, as well as the probable genesis of these deposits. The writer now passes to the analysis and chemical

[1] Louis Duparc and Marguerite N. Tikonovitch, "Platinum and Platinum Deposits," pub. by "Société Anonyme des Editions 'Sonor,'" 46 Rue du Stand, Geneva, Switzerland, 600 pp., 99 text ill., 90 stereotype pls., 11 in black and color, 8 of dredges, etc., atlas of Ural deposits, 4°.

composition of platinum, as investigated by the ordinary methods used and certain new ones that have been applied. The average content of deposits is presented as a test of the eventual results of working them, and the differences in the composition of native platinum from the principal deposits are noted. Secondary deposits and platiniferous alluvial, and the extraction of platinum from alluvial, form the subject of two chapters.

The dunitic deposits of the Urals are very fully and extensively presented by Professor Duparc, who has investigated the occurrences of platinum in this region with especial care and thoroughness. The succeeding chapter is devoted to an equally exhaustive examination of the pyroxenitic platinum deposits of this region. Then comes a chapter on the deposits in other parts of the world; in San Domingo, Honduras, equatorial Colombia, Brazil and French Guiana, as well as in North America, where the deposits of the United States, of Mexico and of British Columbia are studied. To these succeed the deposits of Oceania, of Borneo, of New South Wales, Australia, of New Zealand and of Tasmania. Nor are the African deposits in the Transvaal forgotten, while the alleged deposits on the Island of Madagascar are duly mentioned. Asiatic deposits of the Wilui and the Oldoi rivers, and of the Altai, close this comprehensive description.

The treatment of the ore and the metallurgy of platinum are then gone into very fully, and the extraction and separation from one another of the various metals of the platinum group, such as palladium, iridium, rhodium, osmiridium and ruthenium. The melting and moulding of platinum closes this chapter.

The uses of platinum in the arts and industry are then presented, whether for apparatus employed in sulphuric acid concentration, for colalytic mixtures, in photography, in the manufacture of electrodes, in dentistry, in incandescent lamps, in laboratory apparatus, or for various other minor uses. Its employment in jewelry is also duly noted.

A concluding chapter gives a recapitulation of the main results and statistics of the world's production of the metal. This is followed by a bibliographical list.

The whole will form a quarto volume of 600 pages, with 99 text illustrations, 90 stereotype plates, 11 plates in black and colors, an atlas with 5 geological colored maps of the Ural deposits, and 8 plates giving illustrations of the principal installations of buddles, dredges, etc.

The work is issued by the "Société Anonyme des Editions 'Sonor,'" 46 Rue du Stand, Geneva, Switzerland. The first hundred numbered copies are not in trade; for the 500 numbered copies, running from No. 101 to No. 600, the price to subscribers is 100 francs; if purchased through booksellers, 125 francs will be charged.

An interesting recent publication of Professor Duparc (in collaboration with A. Grossett) is a study of the lately discovered platiniferous deposits of the Sierra de Ronda, Spain, in which he draws attention to the similarity of the conditions there to those observable in certain parts of the Ural region.[2]

The new edition of Professor James Lewis Howe's "Bibliography of the Metals of the Platinum Group," which has just appeared, may confidently be pronounced to be a realization of just what a bibliography ought to be.[3] Professor Howe acknowledges his indebtedness to a supplement of his earlier bibliography, issued in 1897, bringing this down to 1910, which was prepared by Dr. Hendrick Coenraad Holtz, then of Amsterdam; the few references in this supplement to American and English works were completed by Professor Howe, and the amplified record was brought down to the end of 1916.

[2] L. Duparc and A. Grossett, "Étude comparée des gîtes platinifères de la Sierra de Ronda (Espagne) et de l'Oural," *Mém. Soc. phys. et hist. nat. Genève*, Vol. 38, fasc. 5, p. 253, 1916.

[3] "Bibliography of the Metals of the Platinum Group, Platinum, Palladum, Iridium, Rhoduim, Osmium, Ruthenium, 1748–1917," by Jas. Lewis Howe and H. C. Holtz, Washington, D. C., 1919, 558 pp., 8vo; U. S. Geol. Surv. Bulletin 694. The first previous edition of 1897 (under the same title) bears only the name of Jas. Lewis Howe; published by the Smithsonian Institution, Washington, D. C., 1897, 318 pp. 8vo.

Professor Howe notes the value of an earlier bibliography he was able to consult, that of Professor C. Claus, contained in his pamphlet entitled "Fragment einer Monographie des Platins und der Platinmetalle." This was published in 1883 by the St. Petersburg Académie des Sciences, from manuscript sheets found among Claus's papers after his death, which had occurred more than twenty years before. The bibliography extends to the year 1861, but, owing probably to the illegibility of the manuscript, many errors have crept in; nevertheless the unique knowledge of this author in the domain of the platinum metals made it of great value. As only 300 copies were printed, this pamphlet is now very rare.

In Professor Howe's earlier edition (of 1897) there were given 61 titles before 1800; 737 between 1800 and 1849, and 1,642 between 1850 and 1896, making in all 2,440 titles. The following recapitulation shows the notable increase in the second edition:

Titles before 1800	65
1800–1849	749
1850–1899	1,823
1900–1916	1,924
Total	4,561

As will be noted, the literature for the seventeen years 1900–1916, gave a larger number of titles than were offered by the preceding half-century. This well indicates the growing importance of this rare and valuable metal. The titles are disposed chronologically, those of each year being separately numbered. In the indexes both the year and the number are given for each title, not the page of the bibliography. The author index, alphabetically arranged, covers 29 pages and embraces nearly 2,500 names. This is followed by an exceptionally full subject-index of 74 pages; under such subject the literature is given in chronological order, with year, number and author's name. It will be seen that no pains have been spared to facilitate the task of any one who is seeking for sources of information as to platinum or any of the platinum metals.

It is to be hoped that this bibliography will be continued, as Professor Howe is still in the prime of life, having been born August 4, 1859, at Newburyport, Mass. He graduated at Amherst in 1880, and received the degree of Ph.D. from Göttingen, Berlin, and Massachusetts Institute of Technology, successively. Since 1894, he has occupied the chair of chemistry in Washington and Lee University. He has done especially valuable work in the study of ruthenium and other platinum metals. He has published a very attractively written biographical notice of the French chemist, Chabaneau (1754–1842), the first maker of a platinum ingot. This weighed some 23 kilograms (about 50 pounds). The writer gives many details of Chabaneau's skill in using the newly-found metal for ornaments, after he had discovered the secret of making it malleable, by taking platinum sponge at a white heat, at the moment of formation, and hammering it repeatedly while in this state.

The titles dating from before 1800, beginning with the first printed mention of the metal in Don Antonio de Ulloa's "Relación histórica del viage á la América meridonal," Madrid, 1748, show that Sweden shares with France and England in the earliest investigations as to its composition and the best methods of refining it. With the names of Watson, Brownrigg, Lewis, Morin, Macquer and Buffon, must be associated those of Scheffer, Cronstedt and Bergman, nor should we forget the Germans, Marggraf and Count von Sickingen. The earliest records of the various platinum metals naturally attract one's attention. The first notice of palladium is in a communication of R. Chenevix to the "Philosophical Transactions," London, Vol. 93 (180–3), p. 290. Tennant's paper on iridium appeared in the *Transactions* for 1804, Vol. 94, p. 411, but his discovery dates from a year or two previous to this time; in 1804, A. F. Fourcroy and L. N. Vauquelin describe it in the *Annales de Chimie*, Paris, Vol. 49, pp. 188, 219. To W. H. Wollaston in 1804 is due the credit of the discovery and determination of rhodium (*Phil. Trans.*, London, Vol. 94 (1804), p. 419), and in the same year Tennant gives the first description of osmium, in connection with that of iridium. The discovery of the sixth mem-

ber of the group, ruthenium, came much later, and was made by C. Claus in 1844; it was first announced in Russian, in his essay for the Demidov Prize, published at Kazan in 1844.

Professor Howe states that the compilation of his first platinum bibliography was probably due to a suggestion made by Dr. H. Carrington Bolton, and his special interest in the platinum group of metals was aroused by a chance remark of Dr. F. W. Clarke, who expressed surprise the chemists were not more interested in them.[4] The series of valuable studies in ruthenium, the least known metal of the group, and the indispensable bibliography, are fruits of thirty-five years of devoted application to the study of this series of metals.

The bibliography takes due notice of those indispensable aids to the investigator and student of the platinum metals, the annual reports of "Mineral Resources" by the United States Geological Survey, and those comprised in the year book entitled "Mineral Industry." In the former this subject has been successively treated since 1904, by David T. Day, F. W. Horton, Joseph Struthers, Waldemar Lindgren, and for several years past by Dr. J. W. Hill, who has contributed a particularly able study of the platinum deposits of the world to the *Engineering and Mining Journal* for 1917, Vol. 103, p. 1145. In *Mineral Industry,* from 1892, the reports have been furnished, in succession, by Charles Bullman, Henry Louis, Joseph Struthers, L. Tovey, Frederick W. Horton, F. Lynwood Garrison, and in the years 1916–1919 by the writer of the present notice, who also contributed the platinum data for the Eleventh Census (of 1890) with photographs he took while studying the deposits and has published in the *Bulletin of the Pan-American Union* for November, 1917, a paper entitled "Platinum: with especial reference to Latin America" (23 pp., with many illustrations), as well as another paper, in a later issue of the *Bulletin,* on the palladium deposits of Brazil.

A work of this kind makes a special appeal at the present time, when the manifold uses to which platinum and the platinum metals can be put, are better known than ever before. The intense demand for the metal in the munition factories, because of its superior resistance to the action of acids, brought it to the notice of many who had barely heard of it in times past. Still the fact that before the war some 500,000 ounces of it had already found employment for catalyzing purposes, as much more for electrical apparatus, at least 1,000,000 ounces for dental work, and another 1,000,000 ounces for chemical vessels, retorts, crucibles, etc., shows that its peculiar merits were recognized by many. Of late years it had become a favorite metal for gem-setting, more especially for diamond-setting, because of the refined beauty of its silvery hue, and its great durability. Another, analogous use, was in the finer articles of jewelry, wherein more truly artistic effects could be secured by its employment than by that of gold.

The gradual increase in value due to these circumstances had already been quite marked before the war. In January, 1909, an ounce of platinum was worth $24.10, only a few dollars more than an ounce of gold ($20.67) but by July, 1914, just before the outbreak of the World War its price had risen to $43.50; indeed it had commanded as much as $46.25 for a brief time in 1911. However, as a result of the special war demand, and of the interruption of the supply from Russia, which had produced annually 90 per cent. of the world's platinum, prices began to soar, until by the early part of 1918 the government set an official limit of $105 an ounce, and took at that figure the entire imports of the metal as well as part of the stocks on hand.

The end of the war, and the removal of this price-restriction, coupled with the sale of the stock accumulated by the government, brought about, for a very brief time, a trifling reaction to be soon followed by a resumption of the upward movement, so that at present, in February, 1920, as much as $165 has been paid for an ounce of platinum, making it worth considerably more than eight times as much as gold. Many coin collectors are familiar with the Russian platinum coins issued be-

[4] From a personal communication of Professor Howe's dated February 17, 1920.

tween 1828 and 1845, during which period 1,373,091 three-ruble pieces were minted, besides a few six-ruble and 12-ruble pieces. The three-ruble piece was worth $2.33 and it weighed 10.3 grams, for platinum was then worth but $7 an ounce; with platinum at $165 an ounce, the intrinsic value of such a coin to-day would be more than $54 of our money.

In view of the fact that the platinum output continues to be much smaller than some years ago, while the increasing demand for jewelry purposes offsets the falling off in the demand for munitions processes, it appears likely that the price will continue to go up, at least until the full resumption of platinum mining in Russia serves as a check. The search for the discovery of new sources is being diligently prosecuted, and Colombia seems the most hopeful of all the regions except Russia.

The newspaper notoriety given to platinum, because of the great legitimate demand for it and the consequent astonishing rise in value, before long excited the cupidity of dishonest persons. As a consequence of this there have been numerous thefts of the material. In several cases, valuable specimens of platinum have been purloined from museum collections, and chemical utensils made of platinum have been stolen from a number of chemical laboratories. Indeed, in one instance an entire university laboratory was burned down to hide the theft of platinum.

As to future prospects, an extensive development of the platinum resources in the Republic of Colombia is in active progress. Possibly Canada may contribute somewhat by improved methods of refining the copper-nickel ores, and similar ores mined elsewhere may also furnish considerable platinum. However, the most encouraging sign is the reported determination of Soviet Russia to issue platinum certificates, that is to say, certificates secured by the platinum stock that has been accumulated in Russia and has not fallen into the hands of the Allies, or will be mined now and in the future.

GEORGE F. KUNZ

SEXUALITY IN MUCORS. II

"NEUTRAL" RACES

As regards the intensity of sexual reaction, however, a gradation is clearly shown. A more detailed view of the complete table showing the combinations only where reactions might be expected, can be seen more clearly (Table I.). The higher grades of A and B predominate at the upper left-hand corner while at the opposite corner are only O's with C's and D's between. There is therefore in this species, varying degrees of sexual activity from the strongest down through the weakest to so-called "neutrals" which fail to show any sexual reaction under the conditions of the experiment. The word "neutral" is obviously only a relative term since, if the two races Nos. 811 and 367 had not been used as testers, No. 370 would have been classed as a neutral. It is possible that the 3 so-called neutrals would have taken part in zygospore formation if strong enough testers of the proper sex had been available or if more favorable environmental factors had been present. The fewer the number of tests made and the more unfavorable the environmental conditions, the larger will be the number of races listed as neutral from any collection of races of a given species.

A change in sexual activity tending toward neutrality may be brought about by environmental factors. Thus we have obtained a temporarily neutral condition in both the plus and minus races of *Mucor Mucedo* by growing them for several non-sexual generations at unfavorably high temperatures. The sexual activity can be regained in a few generations by cultivating them at low temperatures. In the same species the spores in a germ sporangium frequently are neutral in reaction but later become sexually active. One of my most active forms (*Mucor* V) has become much reduced in sexual activity since its opposite races were first separated some sixteen years ago. A similar reduction in sexual vigor resulting in neutrality has been reported in a number of species by other investigators. In *Phycomyces* the plus and minus spores in a germ sporan-

TABLE I

"Dark" Absidia

← Grade		Grade →	2.55	2.39	2.33	2.06	2.06	1.78	1.61	1.56	1.56	1.50	1.44	1.44	1.39	1.33	1.33	1.33	1.28	1.00	0.11	0.00	0.00	0.00
			Plus (+) Strains																			Neutral Strains		
			369	203	345	359	366	348	202	347	353	716	350	364	201	351	356	357	355	714	370	354	360	368
2.53	Minus (−) Strains	571	B	A	B	C	B	A	C	B	B	C	B	C	B	B	C	C	C	C	O	O	O	O
2.21		713	C	B	A	B	C	B	C	C	C	B	C	C	C	C	C	C	C	C	O	O	O	O
2.16		811	B	B	B	C	B	C	C	C	C	B	D	C	C	C	C	C	C	C	D	O	O	O
2.10		365	A	A	B	B	A	A	C	C	C	C	C	C	D	D	C	D	O	D	O	O	O	O
2.10		711	A	B	C	B	C	C	C	C	C	C	C	C	C	C	C	C	C	C	O	O	O	O
2.05		362	B	C	B	C	C	C	C	C	C	C	C	C	B	C	C	C	C	C	O	O	O	O
1.84		349	C	D	B	C	C	C	C	C	C	B	C	C	D	C	C	C	C	D	O	O	O	O
1.84		352	B	C	C	C	C	C	C	C	C	C	C	D	D	C	C	C	C	C	O	O	O	O
1.68		363	B	B	B	D	C	C	C	C	O	C	O	C	C	O	C	C	C	C	O	O	O	O
1.58		572	B	B	C	C	C	C	C	C	C	C	D	D	C	O	D	D	C	O	O	O	O	O
1.58		715	C	C	B	C	C	C	C	D	C	O	C	C	C	C	D	C	D	O	O	O	O	O
1.42		346	B	C	D	A	C	D	C	D	C	O	C	D	D	D	C	D	D	O	O	O	O	O
1.42		367	C	C	C	D	C	D	D	C	D	C	D	D	D	D	D	C	C	D	D	O	O	O
1.42		712	B	C	C	B	C	C	D	D	D	O	D	C	D	C	D	D	D	D	O	O	O	O
1.11		371	C	C	C	D	D	D	C	D	C	D	C	D	D	D	O	O	O	O	O	O	O	O
0.68		358	D	C	D	D	C	O	D	D	D	D	D	D	O	O	O	O	O	O	O	O	O	O
0.53		717	C	C	D	C	C	O	O	O	O	O	O	O	O	D	O	O	O	O	O	O	O	O
0.26		638	D	D	C	D	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
0.00	Neutral Strains	354	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O		O	O
0.00		360	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O		O
0.00		368	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	

gium may produce mycelia, neutral toward each other, though reacting with the plus and minus parent stocks. Here again the neutrality or self-sterility is only temporary, since after a few spore generations their ability to take part in active zygospore formation *inter se* is completely established.

In nature the number of neutral strains appears to be large and many species have been studied, the races of which have never been induced to react, either *inter se* or with strong testers of other species. There is no evidence that even in these cases, the neutrality is absolute and the races completely devoid of sexual tendencies. Their apparent neutrality may mean merely that we have not yet happened to expose these forms to the peculiar environmental conditions necessary for an expression of the sex which is actually present.

SEXUAL DIMORPHISM

Similar tabulations of the sexual reactions between their races have been made for several species beside the "dark" Absidia and with similar results (Table II). All the races which were able to assist in zygospore formation appear to be sexually dimorphic, consistently either plus or minus. A few investigators have believed they have found evidence in certain species that would militate against sexual dimorphism in the diecious mucors. In a specific instance (8), however, where it was possible to retest the material upon which such conclusions were based, it was found that the dimorphism was in fact present but, for

TABLE II

SUMMARY, DECEMBER 19, 1919

	No. Locations Represented	No. Gross Cultures	No. Races	No. Combinations Possible $\left[c = \frac{n(n-1)}{2}\right]$	No. Testers Used	No. Combinations Made	Plus (+)	Neutral (N)	Minus (−)
Absidia cærulea	3	12	22	231	22	*231	4	5	13
A. glauca	5	5	10	45	10	*45	4	0	6
A. sp. (whorled)	11	15	34	561	34	*561	14	2	18
A. sp. (dark)	13	26	40	780	40	*780	19	3	18
Phycomyces			15	105	15	*105	11	3	1
Cunninghamella bertholettiae	18	36	92	4,186	14	1,183	13	8	71
C. elegans	1	16	42	861	12	426	25	1	16
C. echinulata	14	25	72	2,556	2	141	9	55	8
Syncephalastrum	18	35	80	3,160	18	1,269	37	4	39
Circinella spinosa	13	28	54	1,431	4	206	36	5	13
Rhizopus			236	27,730	20	1,574	89	85	62
Choanephora cucurbitarum	2	19	33	528	10	275	5	0	28
Total			730	42,174	201	6,796	266	171	293
Mated strains not listed above			34		4	102	16	0	18
Unmated strains			248		4	511	51	108	89
Total additions			282		8	613	67	108	107
Total			1,012		209	7,409	333	279	400
Zygospore Germinations									
Mucor Mucedo			512		514	1,280	46	432	34
Phycomyces			392		394	980	258	16	118
Zyg. Germ. totals			904		908	2,260	304	448	152
Grand totals			1,916		1,117	9,669	637	727	552

* All possible combinations made.

various reasons, has been misinterpreted by the investigator.

Burger, in a recent paper (11) concludes that sexual dimorphism does not exist in the mucor genus *Cunninghamella*. He reports finding certain races, among 25 or 26 of *C. bertholettiæ* studied, which will form zygospores with both plus and minus races. In other words a race A will conjugate with race B, B conjugates with C and C conjugates with A, and the family triangle is complete. In personal conversation, Dr. Burger has told me that he has found a similar condition in *Syncephalastrum*. It is not appropriate at the present time to enter into a discussion of Burger's paper. It will be sufficient to say that we have used some of the same strains that he worked with and, except for infections in an early series of contrasts before we discovered the great danger in *Cunninghamella* of contamination of a culture with spores of the opposite sex, we have never had results at all comparable with his. The negative results obtained by us do not, of course, prove that sex intergrades or hermaphrodites never occur in diecious species. He would be a rash philosopher who would deny to any protoplasm the possibility of reacting in an unexpected manner. They do indicate, we believe, that the occurrence of such sexual conditions must be, at best, a rare phenomenon. In view of the work tabulated in the accompanying table, it seems wisest therefore, to leave out of discussion, for the present, unconfirmed conflicting conclusions which are based on relatively meager material.

In the first 5 species of the table (those marked with a star) all the possible combina-

tions have been made. For the others it would obviously have been too enormous a task to have been profitable. The races from zygospore germinations have been added as being likely to show through segregation sexual abnormalities if such existed. Nearly 10,000 combinations have been made using nearly 2,000 different races of diverse types of mucors and no race of a diecious species has been found which, if it showed any sexuality at all, reacted other than as a plus or a minus.

We have just been discussing *intra*-specific sexual reactions. The next table shows *inter*-specific reactions previously discussed under the term "imperfect hybridization." In testing the reactions between the plus and minus races of two different species, all the four possible interspecific combinations have been made but, since the combinations between races with like signs have never given reactions, they have been omitted from the table. Only a part of the possible combinations have yet been tested, but sufficient to indicate that the same sexual dimorphism exists in all the species investigated.

We feel justified in concluding from our experience, that the forms in the tables are sexually dimorphic. From our experience with the diecious sporophytes of willows and poplars, such a strict dimorphism was hardly to have been expected. It would be a safe wager that one could not examine even a hundred individuals of either of these genera without finding sex intergrades. The apparent sharper differentiation of sex in the diecious mucors in comparison with higher plants is perhaps connected with the fact that in mucors we are dealing with sexually differentiated gametophytes instead of with sporophytes.

GAMETE DIFFERENTIATION

I should like to close our discussion by a consideration of gamete differentiation in mucors and other forms. As a general rule, all of the diecious mucors represented at the top of the chart (Fig. 4) have gametes equal in size. Of the hermaphrodites there are two types—those with equal gametes (isogamic), figure below, and those with a constant and marked difference in size (heterogamic), figures at right and left. We can conceive of the hermaphrodites as having been derived from the diecious types or the diecious types from the hermaphrodites. If the latter be the actual course of evolution, we may conceive a differentiation of sex to have taken place in two directions beginning with the isogamic hermaphrodites—first toward a differentiation, chiefly physiological, separating the sexes on separate plus and minus individuals in diecious forms; second toward a differentiation, conspicuously morphological, bringing about a constant difference in the size of the gametes in the heterogamic hermaphrodites. The prevalent biological distinction between males and females is based ultimately upon the relative size of the gametes which they produce. The smaller gamete is considered the male; the larger recognized in the left figure by the outgrowths behind it, is considered the female. The diagram (6) shows the reactions obtained in attempting, by use of this criterion of sex, to homologize the plus and minus signs with the terms male and female or vice versa. The hermaphrodite, which is heterogamic, is grown between the plus and minus races of *Mucor* V. On the right its smaller gamete reacts with the plus

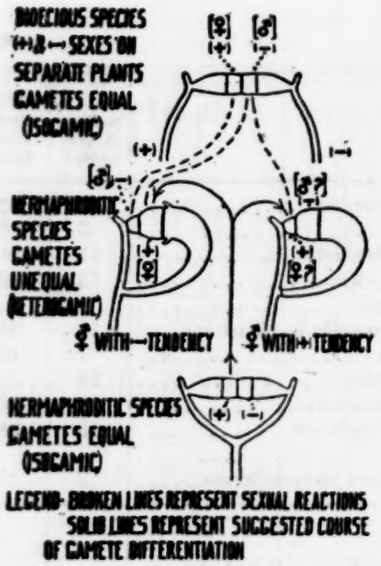

Fig. 4. Diagram illustrating sexual reactions and gamete differentiation.

race and on the left its larger gamete reacts, though but weakly, with the minus race. The smaller gamete is therefore minus and the larger plus. On the assumption that the smaller gamete is male and the larger female, the minus race must be considered male and the plus race female.

In our previous diagram (Figure 4) we recognize on the left the heterogamic species (*Absidia spinosa*) just discussed, by the outgrowths back of the larger gamete. That heterogamy has actually been derived from isogamy in this species is rendered probable by Lendner's report (12) of finding a race of the same species with equal gametes. The broken lines, connecting the unequal gametes on the left with the plus and minus diecious species above, represent the reactions which have taken place and indicate that the larger gamete is plus and the smaller gamete, minus. The isogamic hermaphroditic species below also reacts with the diecious form above and hence its gametes also may be labelled plus and minus. The plus gamete of the lower isogamic species may be considered, in the process of evolution, to have given rise to the larger gamete of the left-hand figure as indicated by the solid line. This is an orthodox interpretation and consistent with the facts so far discovered for this species. There are some facts, however, which indicate that such is not the necessary course of evolutionary development in all forms.

It has been shown that although the plus race is perhaps usually more vigorous than the minus, this condition is sometimes reversed. Some hermaphrodites have predominatingly plus and some predominatingly minus tendencies. Is there any intrinsic reason why, of two equal gametes, the plus should invariably become the larger in the process of size differentiation? I do not believe that there is. If not, we should expect to find forms like the one figured on the right where the plus gamete is represented as having given rise to the smaller of the heterogamic pair. In *Zygorhynchus heterogamus*, we have perhaps such an example. The evidence is not entirely conclusive since we have obtained reactions as yet only with one of the paired test races and the larger suspensor fails to show outgrowths which might help in distinguishing the unequal gametes when reacting with other forms. However, the appearance of the reactions between the right-hand figure and the minus race resembles that between the left-hand figure and the plus race. The figure on the left has a minus tendency, the same as its smaller gamete while the figure on the right has a plus tendency also the same apparently as its smaller gamete. No one realizes more strongly than the speaker that the specific case under discussion is in need of more thorough investigation. Whether or not my suggested interpretation of the right-hand figure proves to be the correct one, it will serve to call attention to the fact that those who define male and female in terms of size differentiation in the sex cells are making the gratuitous assumption that quantitative differences in the gametes are the fundamental peculiarities of the two sexes. I have used from preference, therefore, the terms plus and minus because I have wished to speak in terms of the physiological differentiation into sexually dimorphic races established in diecious species rather than in terms of male and female which are defined by differentiation in size of gametes and which conceivably may be secondary sex characters.

I trust it will be granted that there is something fundamental, common to all the plus races that causes them to react sexually with minus races in the same or in different species and that this same fundamental something is present also in hermaphroditic forms whether possessed of equal or of unequal gametes. Dr. Gortner and I some years ago started an investigation based upon the assumption that the fundamental differences between the sexes might possibly be bound up with differences in sex proteins. The work was unfortunately interrupted before a definite conclusion could be reached with the delicate blood reactions employed. If we are able to imagine some fundamental biochemical constitution such as a sex protein, common to all the plus proto-

plasms in the mucors, we may be able to spur our imagination still further to conceive of this same constitution as existing in one of the two sexes in all organic forms. It might then be theoretically possible by proper technique to obtain reactions with our isogamic plus and minus races of the mucors and thus have males and females in different groups of plants and animals compared on a common and fundamental basis. If this highly imaginative proceedure were possible, is there any reason to believe that the so-called males in all groups of plants and animals would invariably be related to the same sex—plus or minus of the mucors? It might transpire that the so-called females of the moths and birds, to take an extreme example, would be found by their reactions with test mucors to bear the same sign—plus or minus—as the males of flies and mammals.

Sex has apparently developed independently many times in different groups of plants and animals. The term male and female are applied to the end products seen in visibly dimorphic gametes. There is no assurance that these terms have laid hold of the fundamental differences between the two sexes. Spines, superficially similar, are developed on the porcupine, jimsonweed and sea urchin, yet these have no close genetic relationship to one another. They are examples of parallel development in unrelated structures—in other words they are to be considered analogous rather than homologous organs. Is it not possible that visible differences in dimorphic gametes are also analogous rather than homologous; that the sperm in one form may be homologous to the egg in another form? It is suggestive in this connection that the males of mammals have this in common with the females of birds—that they produce two kinds of gametes. Moreover, it is the sex glands of the male of mammals and of the female of birds which form hormones influencing profoundly the expression of the secondary sex characters, albeit in a somewhat different manner. I do not suggest that in starting with human terminology, as we generally have done in describing lower organisms, we should call the rooster a female and the hen a male. I wish merely to call attention to inadequately explained sexual phenomena in higher forms in which similarities in the gross morphological differentiation of the so-called male gametes of two forms are not associated with certain physiological peculiarities which are common rather to the opposite sexes.

It seems reasonable to consider in mucors the physiological sexual differentiation into plus and minus races, more expressive of any fundamental peculiarities of sex, if such actually exist, than the size differences and associated phenomena in higher forms. Sperm cells, in addition to being gametes, are organs of locomotion and the egg cells, in addition to being gametes, are storage cells to supply nourishment to the developing zygote. Motility in the sperm and storage in the egg we can conceive of as secondary rather than primary sex characters. It is not alone the gametes of higher forms in which we find differences associated with the diverse functions of bringing the gametes together and nourishing the zygote formed by their union, but also the two sexual organisms themselves may have their sexual differences related directly or indirectly to these same somewhat conflicting functions.

The diecious mucors seem largely free from such secondary sexual characters which may tend to obscure more fundamental sexual differences. Their gametes are normally equal in size and nourishment for the developing zygote is supplied approximately in equal amounts from both sexes. Moreover, in those few forms in which the conjugative filaments seem to exercise attraction toward each other, such attractions seem to be mutual and equal.

It would carry us too far to attempt to meet the objections of cytologists or of others to our hypothesis of gamete differentiation or to attempt to show in what other ways the sexual differentiation in mucors may be of interest to students of higher forms. We will be satisfied, however, if we have shown that the simple bread mold may eventually be of some service in helping to solve the funda-

mental problems of sex, for we believe that many of these problems are to be solved only with the structurally simpler forms of life like the mucors.

ALBERT F. BLAKESLEE
CARNEGIE STATION FOR EXPERIMENTAL EVOLUTION

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SCIENTIFIC EVENTS

THE DIVISION OF STATES RELATIONS OF THE NATIONAL RESEARCH COUNCIL

A STATEMENT concerning the work of the division has been issued by the council, in which the chairman, Professor John C. Merriam, of the University of California, writes:

The Division of States Relations is organized with special reference to the consideration of research interests related to organization of the states as political and economic units. In our commonwealth the state presents an important form of organization for the development of certain aspects of science. The function of science in such a unit is to direct the conservative use of the state's natural resources, to increase productivity, to improve sanitation, and in other ways to promote prosperity and the public welfare. The purposes of this division may be stated in simplest form as follows:

1. To obtain information as to the most effective types of organization for groups of departments concerned with research within state governments.

2. To become acquainted with the best methods of cooperation among the institutions within the state—educational, commercial and industrial—which are concerned with scientific research.

3. To study the wider outside relations of research in state organizations, including the contracts with activities of other states and with national agencies of the country.

However, much information upon the present situation is needed before steps can be suggested for the closer coordination of state scientific agencies. The division is, therefore, undertaking a study of the present relationships of the various scientific agencies in the government of a number of the states. Several systems for the organization of state scientific departments are in operation, some, presumably, with better effect than others. Relations have been variously developed between these state departments and the scientific groups in state educational institutions. The relation between research work in many state departments and the work of enforcing the regulations based upon scientific investigation has attracted attention from the point of view both of science and of political economy. Moreover, determination of the most satisfactory forms for central bodies which may be used to organize scientific effort within states, and of the auspices under which such bodies should act will require much careful study. The nature of the state organization must be adapted to the particular situation found in the state in which it may seem desirable to organize such a body. It is believed that careful review of present conditions and of means for improving them is warranted by the possible gains in the

progress of science and the advance in public welfare which may be expected from the most rational development of these scientific agencies. The division bespeaks the cooperation in this study of all those who are interested in this aspect of the advancement of science.

SUMMER MEETING OF THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

The summer meeting of the institute will be held in Canada. The date has been fixed tentatively as June 21–26. Plans as worked out at present include a meeting of two days, Monday and Tuesday, at Montreal, for the business sessions, reading of papers and possibly one or two excursions to chemical industries in Montreal.

The program of papers to be presented is being prepared and the secretary desires information as to papers being prepared for presentation at this meeting. Members are urged to present to the society as many papers as possible in order to make the meeting profitable and the *Transactions* valuable. Papers on any phase of chemical engineering work would be welcome. A special endeavor is being made to secure papers on electrolytic industries and papers on this subject are especially desired.

Wednesday will be spent at Ottawa visiting the copper and nickel refinery of the British-American Nickel Corporation, also inspection of the government buildings and the laboratories of the Bureau of Mines.

Thursday and Friday will be spent at Shawinigan Falls seeing the power development and the electrolytic industries located in this vicinity.

Saturday will be spent at LaTuque where we have secured permission from the Brown Company for a visit to the very large sulphate pulp mill where the explosion process described by Hugh K. Moore at our Savannah meeting is in operation. From this point a trip is being planned to the very large artificial lake which has been made at La Loutre. This includes a 50 mile boat trip, stopping at a fishing camp on the lake where there will be opportunity for motor boating and fishing. After a stop of a day or two in this very picturesque and wild part of Canada, the return trip will be made to Quebec.

J. C. Olsen,
Secretary

THE AMERICAN PHYSICAL SOCIETY

The one hundred and third regular meeting of the American Physical Society will be held in Washington, at the Bureau of Standards, on Friday and Saturday, April 23 and 24. The first session will begin at 10 o'clock on Friday morning. The program contains the titles of forty-six papers.

The other meetings for the calendar year will be as follows: The Thanksgiving meeting, on November 27, will be held at Case School of Applied Science in Cleveland, instead of in Chicago. The annual meeting, beginning on December 28, will be held in Chicago, this being the occasion of the special Quadrennial Meeting of the American Association for the Advancement of Science and the Affiliated Societies. The October meeting will be omitted for the year 1920.

The Pacific Coast Section will hold a meeting at the University of Washington, in Seattle, at the time of the meeting of the Pacific Division, A. A. A. S., June 17–19, 1920. Correspondence relating to this meeting should be addressed to the Secretary of the Pacific Coast Section, Professor E. P. Lewis, University of California, Berkeley, California.

Dayton C. Miller,
Secretary

Case School of Applied Science

SCIENTIFIC NOTES AND NEWS

The National Academy of Sciences will hold its annual meeting at the U. S. National Museum, Washington, D. C., April 26, 27 and 28. The William Ellery Hale Lecture will be given on April 26 by Dr. Harlow Shapley, of the Mount Wilson Solar Observatory, and Dr. Heber D. Curtis, of the Lick Observatory, on "The Scale of the Universe."

The American Philosophical Society is holding its general meeting in Philadelphia on April 22, 23 and 24. On the evening of the

twenty-third, Professor R. W. Wood, of the Johns Hopkins University, lectures on "Invisible Light in War and Peace."

DR. JAMES R. ANGELL, professor of psychology in the University of Chicago and dean of the university faculties, this year chairman of the National Research Council, has been elected president of the Carnegie Corporation, New York.

PROFESSOR THEODORE W. RICHARDS and Professor George D. Birkhoff, of Harvard University, have been elected members of the Danish Academy of Sciences.

THE Royal Irish Academy has elected as honorary members Professor George Ellery Hale, Professor A. E. H. Love, Sir Ernest Rutherford and M. Henri Louis le Châtelier.

THE founder's medal of the Royal Geographical Society has been awarded to Mr. H. St. John B. Philby, for his two journeys in south-central Arabia, 1917 and 1918; the Patron's medal to Professor Jovan Cvijic, rector of the University of Belgrade, for studies of the geography of the Balkan Peninsula; the Victoria medal to Lieutenant-Colonel H. S. L. Winterbotham, for his development of scientific methods of artillery survey and the production of maps of inaccessible areas.

OFFICERS of the Malacological Society of London for 1920 were elected at the annual meeting on February 13 as follows: *President:* G. K. Gude; *Vice-Presidents:* H. O. N. Shaw, T. Iredale, J. R. le B. Tomlin, and A. S. Kennard; *Treasurer:* R. Bullen Newton; *Editors:* B. B. Woodward; *Secretary:* A. E. Salisbury.

A CORRESPONDENT writes: "The many friends of Professor Ludwig von Graff, formerly head of the Zoological Institute of the University at Graz, Austria, and well known for his work upon the Plathelminths, will be sorry to hear that he is suffering with arteriosclerosis, and that since the beginning of the war he has not been able to do any mental work. Owing to the great depreciation of Austrian money, he and his family are in straitened circumstances."

WILLIAM T. SEDGWICK, professor of biology at the Massachusetts Institute of Technology, left the United States this week for England, where he will serve as the institute's first exchange professor to the universities of Leeds and Cambridge.

DR. EDWARD P. HYDE, director of the Nela Research Laboratory, Cleveland, sailed for Europe on April 13, in connection with business for the International Commission on Illumination, of which he is the vice-president. He expects to return to this country in July.

DR. J. O. HALVERSON, associate in the department of nutrition of the Ohio Agricultural Experiment Station, the past three years, has been appointed to take charge of similar work in the Agricultural Experiment Station at Raleigh, N. C.

MR. R. A. MCGINTY, associate professor of horticulture in the Colorado Agricultural College and Experiment Station, has resigned to enter the employment of a canning company at Canon City, Colorado.

MR. R. H. BULLARD, instructor in chemistry at Hobart College, has accepted a position in the research department of the Roessler & Hasslacher Chemical Co., Perth Amboy, N. J.

DR. PIER ANDREA SACCARDO, the distinguished mycologist and professor emeritus of the Royal University of Padua, Italy, died on February 12, in the seventy-fourth year of his age. Professor Saccardo was a member of numerous academies and societies both Italian and foreign, and is known to all pathologists and mycologists by his great Sylloge Fungorum.

MR. J. S. MACARTHUR, the English industrial chemist, known for his part in the discovery of the cyanide process for the extraction of gold and other metals, and for the work in chemistry and mining, died on March 16.

THE Dartmouth Scientific Association organized in February, 1870, observed its fiftieth anniversary on the 18th inst. by the presentation of an address on "The Founders" by the only living member of the original seven, Dean-Emeritus Charles F. Emerson. Professor Emerson has been an active member

from its organization, as he has been connected with the college as student and teacher for fifty-five years, and has seen the College expand from 176 students to 1738. So far as reports from colleges and universities in America could be secured, this Scientific Association has maintained the longest continued existence without a lapse of meetings, twice a month, except vacations. The association is now in a most prosperous condition with about 70 members.

Northwestern University department of chemistry has received a grant of $3,500 from the Interdepartmental Social Hygiene Fund of the United States Government. This fund is for the purpose of supporting research leading to the development of new metallo-organic compounds which may prove of therapeutic value in the treatment of syphilis of the central nervous system. A plan of cooperation has been worked out between the Universities of Wisconsin, Minnesota, Illinois, and Northwestern whereby all pharmacological work will be done by the first-named institution and the synthesis of new compounds by Minnesota, Illinois and Northwestern in cooperation.

A sum of money has been raised by the olive growers and the canning industry for an intensive study of botulism in California. The investigation will be conducted in the laboratories of the Stanford University Medical School and the George William Hooper Foundation for Medical Research of the University of California and has the cooperation of the U. S. Health Service and the California State Board of Health. The investigation will include a careful study of the distribution of the *Bacillus botulinus* in nature, of the ways in which food materials may become infected and of the steps necessary to destroy the organism when it has infected raw food materials. A staff of specially trained workers has been engaged and it is expected that the work will require at least two years.

Concurrently with the introduction of a bill into the United States Senate by Senator Johnson providing for the establishment and maintenance by the United States Forest Service of a Forest Experiment Station in California in cooperation with the University of California, the Division of Forestry at the State University has expressed the opinion that such an experiment station "would be of great importance to every one interested in California forests." It was stated that the Forest Products Laboratory established about ten years ago at the University of Wisconsin has not only developed into a large and important institution doing work known throughout the country, but that it is now the leading institution of its kind in the world. "There is no reason why the Forest Experiment Station proposed for California to enable scientific investigation of forestry problems should not also become the leader in its field." An initial appropriation of $25,000 is suggested in Senator Johnson's bill, it was stated. The work of the staff of the proposed station would be carried on in cooperation with the faculty of the Division of Forestry of the University of California.

A British Association of Research for the cocoa, chocolate, sugar, confectionery, and jam trades has been formed in accordance with the government scheme for the encouragement of industrial research. The association will establish and maintain laboratories and conduct experiments, and powers are also taken to encourage the technical education of persons engaged or likely to be engaged in the allied trades. The government will contribute, with certain limits, out of the funds of the Imperial Trust for the encouragement of scientific and industrial research a sum equal to that subscribed by the members themselves for five years.

Among recent appropriations made in Cuba there is one providing $225,000 to remodel the Hospital Las Animas of Havana and to erect a monument to Dr. Carlos Finlay at the entrance of the hospital.

The Rockefeller Institute for Medical Research has received a letter from Surgeon-General William C. Braisted, U. S. Navy, testifying to his appreciation of the valuable aid rendered by the institute in connection

with the War Demonstration Hospital, New York City. The assistance was not limited to the active period of the war, but continued after the signing of the armistice.

THE eighteenth annual meeting of the North Carolina Academy of Science will be held on April 30 and May 1, at the N. C. State College, West Raleigh. Professors A. H. Patterson, physicist, and R. W. Leiby, entomologist, are president and secretary-treasurer, respectively.

UNIVERSITY AND EDUCATIONAL NEWS

THE family of Henry Phipps have given $500,000 to the Henry Phipps Institute of the University of Pennsylvania for the study of tuberculosis.

MR. JAMES F. BRADY and Mr. Vincent Astor have subscribed $250,000 to the two million dollar endowment fund of the New York Post Graduate Medical School as soon as the first million dollars has been raised.

DR. ALBERT W. SMITH, dean of the college of mechanical engineering of Cornell University, has been appointed acting president of the university during President Schurman's leave of absence. President Schurman will resume office on June 1, retiring on June 23.

MR. ALBERT E. WHITE, formerly head of the metallurgical branch, technical staff of the Ordnance Department, has returned to his former position as professor of chemical engineering at the University of Michigan, Ann Arbor, Mich.

DR. WILLIAM LEONIDAS BURLISON, professor of crop production of the University of Illinois, has been appointed head of the department of agronomy, to fill the vacancy caused by the death of Dr. Cyril G. Hopkins.

DISCUSSION AND CORRESPONDENCE

CEREBELLAR LOCALIZATION BY THE APPLICATION OF STRYCHNINE

THERE exists, at the present time, a considerable diversity of opinion with respect to the localization of functions in the cerebellum. The conception of cerebellar localization is based on the studies of Elliot Smith, Bolk, van Rynberk, André-Thomas and Bárány. Nevertheless, in a recent study of war wounds involving the cerebellum, Gordon Holmes was unable to find definite evidence in support of the localization doctrine.

The present writer is conducting a series of experiments in which an effort is being made to solve the problem by the application of strychnine to the cerebellar cortex. The experiments are being performed on cats anesthetized with chloroform and ether. Tracheotomy is carried out and both carotid arteries are ligated. The left cerebellar hemispere is then exposed. A 1 per cent. solution of strychnine nitrate containing methylene blue is applied to the surface with a small pledget of absorbent cotton. Any excess is carefully wiped off and spreading to the medulla oblongata is precluded by the use of thick vaseline. The area covered by the strychnine solution apparently embraces the "crus secundum" and to some extent the "crus primum" of Bolk. The crus secundum, according to van Rynberk, is concerned with the ipsilateral hind limb, whilst the crus primum is concerned with the ipsilateral forelimb.

After applying the strychnine the animal is laid on its back and the narcosis is allowed to subside slightly. Within about 5 minutes it is found that flexion applied to the ipsilateral (left) hind leg at ankle, knee and hip evokes a succession of regular tremors which may persist for an indefinite period. Mechanical stimulation or faradization of the pads of the foot yields a like result, which is also evokable by induction of the knee-jerk. Frequently the leg is carried by the rhythmical tremors into a condition of sustained extension, which recalls vividly the condition met with in "decerebrate rigidity."

Application of the above-mentioned modes of stimulation to the contralateral (right) hind leg is usually without result but at times phenomena of similar kind are induced. These, however, are weaker and of shorter duration than in the ipsilateral limb. It ap-

pears possible that when a minimal quantity of strychnine is employed the reactions described will be found to be confined to the ipsilateral hind leg. Together with the hind limb phenomena just described there is usually to be noted a rigidity affecting both forelimbs, which again strongly recalls the appearances of decerebrate rigidity.

The reactions above depicted do not appear to be due to an action of the strychnine on the spinal cord and bulb, since the symptoms are confined to the hind and forelimbs. Vigorous stimulation of other parts of the body, *i. e.*, the trunk and head elicits not the slightest indication of strychnine convulsions. There is no opisthotonus; the lower jaw is constantly relaxed and the mouth open.

Magnini and Beck and Bikeles had previously applied a solution of strychnine to the cerebellar cortex for the purpose of localization. The effects described by these authors were, however, of an indefinite character and involved widely-separated regions of the body. According to Luciani the reactions were in part due to diffusion of the drug to the medulla oblongata and the observations of the writers cited lend no support to the doctrine of cerebellar localization. In my experiments, on the contrary, precautions were taken to prevent spread of the drug to the medulla oblongata and the symptoms themselves were of a definite and restricted nature. My experiments are being continued on the cat and the method will be extended to the study of the cerebellum of the dog, monkey and other animals.

Frederick R Miller
Western University Medical School,
London, Canada,
March 22, 1920

A LOGIC TEST

To the Editor of Science: I have lately came upon what I regard as the very best Logic-Puzzle that I have ever met with; that it is good is proved by the fact that the people I have put it to have been somewhat equally divided as to whether they answer yes or no to the question involved. Moreover, it is an actual case—a real advertisement of a clothing store that I had the good luck to find in a recent newspaper. This is it:

> We have all known from our youth up that to err is human. If this is so, it must be that all of our competitors are thoroughly human.

The implication is, of course, that "our competitors" are people who make (in their cutting and fitting) plenty of errors, and the inference drawn is that this proves them to be human. Now this is either good reasoning or bad; which is it?

I should be extremely glad to receive answers to this question, and especially if they are accompanied with the grounds for the answer—yes or no.

Christine Ladd-Franklin
Columbia University,
March 2, 1920

THE SITUATION OF SCIENTIFIC MEN IN RUSSIA

A recent letter to Science (March 26, 1920, p. 322) having brought up the question of "the situation of scientific men in Russia," with particular reference to Professor Pavlov, it seems fitting to publish the following letter from Professor Boris Babkin, who was for many years assistant to Professor Pavlov. We are all interested in the welfare of our scientific colleagues in Russia as well as in other countries, and this direct statement may throw some light on the situation.

H. Gideon Wells

The Otho A. Sprague Memorial Institute,
Chicago, Ill.,
April 5, 1920

Dec. 17, 1919.

Physiological Laboratory,
University of Odessa.

Dear Professor Wells,

I take advantage of my old acquaintance with you in E. Fischer's laboratory and beg you to assist me in the following matter.

The bolshevik revolution has brought Russia into such a state that not only has scientific work come to a standstill, but even our lives are in danger. Many professors have been put to death, many are in prison. I consider it necessary to continue my scientific activity. I therefore beg you to help me

to find a post in some physiological laboratory in the U. S. I do not know English well enough to give lectures just at present but in one to one and one half years I would be able to do so. But now I think I could be of use in some research institution.

I have a similar request to make to you on behalf of my friend Privat Docent A. A. Kronforsky, lecturer on pathology and bacteriology at the University of Kieff, whom I can recommend most warmly. He would emigrate to America for the purpose of continuing his scientific work.

Please be so kind to direct your reply (if it is possible cable me) to British Consulat General in Odessa for Professor B. P. Babkin, Physiological Laboratory, University of Odessa.

With kind regards,

Yours sincerely,
B. BABKIN

QUOTATIONS

RESEARCH AND THE UNIVERSITIES

"IMITATION research" is the latest object of attack by the Carnegie Foundation for the Advancement of Teaching. "Much," declares the report "of that which has gone on in American universities under the name of research is in truth only an imitation." This is a strong statement. Most persons familiar with the facts, it is safe to say, will feel that it should be modified by striking out "much" and substituting "some." A favorite game with critics of university work has long been the quotation of subjects of doctoral theses. Even those who should know better are unable to resist the temptation of provoking a laugh at the expense of the scholar who labored to give to the world the boon of several hundred pages on "The Middle English Ideal of Personal Beauty," or "A Study of the Cogmonina of Soldiers in the Roman Legion," or "Plane Nets with Equal Invariants." The Carnegie report does not descend to this level, but it gives aid and comfort to such criticism by coupling its extreme statement about "imitation research" with advice to the universities "to take stock of themselves before appealing to the public for funds on an enormous scale."

That stock taking has already been done, and by an agency as pitiless as this world knows. The direction of our war effort was committed in large measure to the college-trained man. He was, in many important positions, a person cursed with a Ph.D., the stigma that told of seminars and laboratories and—well, research. He came from everywhere, from the fresh-water institution of limited facilities as well as from the university of unrivalled resources. That he "made good" from the beginning is one of the commonplaces of the history of our war. He took hold of a situation as unacademic as the most skeptical of his critics could have imagined, and proceeded as if the war were nothing more baffling than a particularly unruly set of sophomores.

There was not a little running around in circles at Washington during the months following April, 1917, but the specialist, product of the American research methods, did not indulge in it.

The colleges are far from perfect. Many worthless law schools are doing a large business, as Dr. Pritchett's report observes, and it it to be hoped that the Foundation may be as successful in wiping them off the map as it has been with the same brand of medical school. But the public has never appreciated research work at its true value, and the rather sensational language of the report is likely to do more harm than good. We need more research work and not less—more of the kind actually prevailing in the mass of our universities.—*The New York Evening Post.*

SCIENTIFIC BOOKS

Inbreeding and Outbreeding, Their Genetic and Sociological Significance. By EDWARD M. EAST AND DONALD F. JONES. Philadelphia and London, J. B. Lippincott Co., 1919. Pp. 285. 46 illustrations.

No better example than this book affords is likely to be found of the successful carrying out of the purpose of the series of "Monographs on Experimental Biology," which is stated by the general editors in these words: "Biology which not long ago was purely descriptive and speculative, has begun to adopt the methods of the exact sciences, recognizing

that for permanent progress not only experiments are required but that the experiments should be of a quantitative character. It will be the purpose of this series of monographs to emphasize and further as much as possible this development of Biology." Until quite recently discussions of inbreeding, whether by biologists or others, have savored of anything but the "methods of the exact sciences." It is safe to say that no phase of biology has been enveloped in such a fog of superstition, old wives tales, and other sorts of misapprehension as has inbreeding. The investigations of East during the past decade and more have been a potent and pioneer influence in dissipating this fog. It is particularly appropriate that he and his former student Jones should prepare a critical general review of the really scientific work which has been done in this field. It is a service which puts all biologists considerably in their debt.

After an introductory chapter which defines the problem of inbreeding and shows its relation to practical questions of sociology and agriculture, as well as biology, three chapters are devoted to the statement of some elementary biological facts and principles which are essential to any rational discussion of a problem which involves and arises out of the phenomena of reproduction on the one hand, and of heredity on the other hand. These chapters, as would be expected by any one acquainted with the authors' other writings, are models of clear and condensed exposition. Chapter V. deals with "Mathematical Considerations of Inbreeding" in which is reviewed recent work on the measurement of the degree of inbreeding existent in complex pedigrees, and on the gametic consequences which must follow the continued inbreeding of a Mendelian population. The analysis of the latter point shows that the amount or degree of heterozygosity decreases with continued inbreeding. The authors state the expectations in the following words:

> Assuming, then, that the loss of the stimulation accompanying heterozygosity is correlated with the reduction in the number of heterozygous factors, we should expect to find the decrease of heterosis greatest in the first generations, rapidly becoming less until no further loss is noticeable in any number of subsequent generations of self-fertilization, and that on the average the decrease will become negligible from the seventh to the twelfth generation and from then on no further marked change will take place. Segregation of characters and appearance of new types and reduction in variability will also follow the same course. Some cases are to be expected in which stability is reached earlier, and some cases in which it is reached later; or, theoretically it may never be reached.

The next chapter reviews the actual results of long continued inbreeding. The classic data here are afforded, on the animal side, by Miss King's brilliant experiments with the white rat, and on the plant side by the no less outstanding work of East and Jones on maize, corroborated by the concordant but less extensive researches of Shull on the same form. These two great experimental investigations may fairly be regarded as a real triumph of American biology. Operating in a field on which a mass of inconclusive experimentation and uncritical speculation had been carried out these researches of East, Shull and Miss King have essentially *solved* for all time the important features of the problem of inbreeding. We now understand where formerly we speculated. The main aspects of the problem are now matters of exposition not debate. The net result must be stated in the authors' words:

> In tracing the evolution of ideas concerning the effects of inbreeding and outbreeding we must give great credit to Darwin for calling attention to the importance of the phenomena in relation to evolution and for being the first to see that heredity differences, rather than the mere act of crossing, was the real point involved; but with all due credit to Darwin, it was not until Mendelism became known, appreciated, and applied that the first real attack upon the problem was made possible. When linked with Mendelian phenomena it was clearly recognized for the first time that one and the same principle was involved in the effects of inbreeding and the directly opposite effects of outbreeding. Inbreeding was not a process of continual degeneration. Injurious effects, if present, were due to the segregation of characters. In addition to this segregation of characters the fact was established

that an increased growth accompanied the heterozygous condition. All the essential facts were accounted for. A decade later the great extension of knowledge in the field of heredity has made possible a still closer linking of the facts of imbreeding and outbreeding with Mendelism. The hypothesis of the complementary action of dominant factors is the logical outgrowth of former views and makes the increased growth of hybrids somewhat more understandable. The fact of a stimulation accompanying heterozygosity is supplemented by a reason why such an effect is obtained. The former view of a physiological stimulation and the more recent conception of the combined action of dominant factors are not then two unrelated hypotheses to be held up for the choosing of the one from the other. The outstanding feature of the latter view is that there is no longer any question as to whether or not inbreeding as a process in itself is injurious. Homozygosity, when obtained with the combination of all the most favorable characters, is the most effective condition for the purpose of growth and reproduction.

A chapter on the value of inbreeding and outbreeding in plant and animal improvement gives a very sane and well-balanced discussion of the practical application in agriculture of the principles set forth in the earlier portion of the work. So far as thoroughly scientific exposition may hope to do so the bogey of the necessary and inevitable harmfulness of inbreeding is laid to rest. It is pointed out that, so far as may be judged from the past, inbreeding has been the greatest single instrument in the breeder's hands for securing uniformity and the concentration of desirable qualities. It has the further advantage of bringing clearly to light undesirable qualities which may then be easily eliminated by selection or otherwise.

The last two chapters of the book are of a more speculative character, but surely no one will deny to those who have made such solid experimental deposits in the bank of knowledge the right to speculate a bit. The first of these chapters deals with effects upon the individual and the second with effects upon the race. Both chapters may fairly be regarded as among the sanest and most cogent arguments for the integral incorporation of eugenic ideas and ideals into the conduct of the social and political affairs of life which have yet been put forth. The known facts are examined critically, though briefly, and there is a refreshing absence of blind and blatant propaganda. To take a single simple example it is shown with great clearness that the ridding of a racial germ-plasm of defective characters is very far from being the simple process that enthusiastic devotees of sterilization legislation would have us believe. To prevent the multiplication of individuals visibly bearing the defects is, in theory at least, not particularly difficult. But to do this alone will not even approximately solve the problem. The residual and vastly more difficult question concerns the somatically normal transmitters of defective qualities.

Altogether this is a notable book, in which American science may well take pride. It should form a part of the required reading of every student of biology, because nowhere else is there brought together in such clear and well-digested form the results of a mass of experimental work which has successfully lighted a dark corner of biological science.

RAYMOND PEARL

SPECIAL ARTICLES

CORRESPONDENCE BETWEEN CHROMOSOME NUMBER AND LINKAGE GROUPS IN DROSOPHILA VIRILIS

A STUDY of twenty-seven mutant characters[1] in *Drosophila virilis* Sturtevant, reveals the presence of at least five groups of linked genes in this species—in contrast to the four groups in *Drosophila melanogaster* (*ampelophila*). This difference in number of linkage groups agrees in a significant manner with the difference in number of chromosomes in the two species. *D. melanogaster,* as is well known, has four pairs of chromosomes—three large and one very small—and correspondingly has three large groups and one small group of linked genes. *D. virilis,* on the other hand, has six pairs of chromosomes—five large and one

[1] Descriptions of some of these have appeared in two earlier papers: Metz, C. W., *Genetics,* 1: 591–607, November, 1916, and Metz, C. W., *ibid.,* 3: 107–134, March, 1918.

very small[2]—and should, therefore, according to the chromosome theory, have six linkage groups, one of which might be expected to contain relatively few genes. From present evidence it seems probable that the five linkage groups, thus far detected, represent the five large pairs of chromosomes. Detection of the sixth group, representing the very small pair, would hardly be expected until a larger number of mutants had been obtained.

The data upon which these conclusions are based will be published in detail elsewhere, but may be summarized as follows:

Fourteen of the 27 characters are sex-linked, forming Group I. The remaining (non-sex-linked) characters fall into four groups—Group II. with three characters, Group III. with four characters, Group IV. with three characters and Group V. with three characters.

Maps of the five groups, based on crossover values, as determined thus far, are respectively about 90, 40, 60, 0 and 20 units long. These lengths are based, respectively, on data involving 12, 2, 4, 3, and 2 "loci," and hence will probably be extended considerably when more characters are studied. Although the values are only approximations, because of the small number of genes involved, they show that a relatively large amount of crossing over occurs in some of the groups. In the fourth group the three genes appear to be completely linked, but since there is no other evidence to indicate that they are allelomorphs they are assumed, tentatively, to represent three different loci.

Owing to the fact that in *D. virilis*, as in *D. melanogaster*, there is no indication of crossing over in the male, it has been possible to secure clear-cut evidence of the distinctness of the linkage groups, because back-crosses of heterozygous males always give complete linkage, if the genes belong to the same group, or free segregation if they do not. Thus representatives of each group (exclusive of the sex-linked group) have been tested with representatives of every other group and found to give free segregation, whereas with members of their own groups they gave complete linkage. The crossover values were, of course, obtained by back-crossing females instead of males.

It should be noted that in the case of the fourth group no crossing over has yet been detected in either sex, but only three characters have been studied in this group, and there can be little doubt that the sexual difference, as regards crossing over, will prove to be the same here as in the other groups.

Chas. W. Metz
Station for Experimental Evolution,
Carnegie Institution of Washington

[2] See Metz, C. W., *Amer. Nat.*, Vol. L., pp. 587–599, October, 1916.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION H—ANTHROPOLOGY AND PSYCHOLOGY

At the St. Louis meeting of the American Association for the Advancement of Science, Section H presented a two-day program. The Monday morning program was given over to papers of especial anthropological interest. Unfortunately due to conflict in the announcements few were present and the session was postponed, resulting in only a few papers being given. On Tuesday morning the Section united with Section L—Education—in a joint program. The address of the retiring chairman of the Section, Dr. Aleš Hrdlička, was entitled "The relations of anthropology and psychology."

Due to action of the Council of the Association the old Section H—Anthropology and Psychology—has been divided up into new sections. The new Section H will be restricted to anthropology and the new Section I to psychology. Officers for both Sections were elected on Tuesday afternoon.

The officers for Section H—Anthropology—are: *Vice-president of the Association and chairman of the Section*, Dr. G. B. Gordon, University Museum, Philadelphia, Pa.; *Secretary*, Dr. E. Hooton, Peabody Museum, Cambridge, Mass.; *Members of Sectional Council*, Dr. F. W. Hodge, Museum of the American Indian, 1 year; Professor R. J. Terry, Washington University, 2 years; Dr. B. Laufer, Field Museum of Natural History, Chicago, 3 years; and Dr. Aleš Hrdlička, United States National Museum, 4 years.

The officers for Section I—Psychology—are: *Vice-president of the Association and chairman*, Professor Edward K. Strong, Jr., Carnegie Institute of Technology; *Secretary*, Professor F. N. Freeman, University of Chicago (for 4 years);

Members of Sectional Council, Professor W. D. Scott, Northwestern University, 1 year; Professor W. S. Hunter, University of Kansas, 2 years; Dr. J. E. W. Wallin, Psycho-Educational Clinic, St. Louis, 3 years; Dr. Helen T. Woolley, Vocational Bureau, Cincinnati Public Schools, 4 years.

A resolution was received from Felix Neumann, secretary of the Anthropological Society of Washington, in reference to an open letter, entitled, "Scientists as spies," written by Dr. Franz Boas, and which was published in *The Nation* of December 20, 1919.

After the article in question was read and discussed at some length, it was regularly moved and carried that "Section H indorses the resolution of the Anthropological Society of Washington." It was further voted that a committee composed of Dr. R. M. Yerkes, Dr. Aleš Hrdlička and Dr. J. E. W. Wallin, take such action concerning the resolution as they deem appropriate.

The following papers were presented:

Notes on the variation between the right and left limbs of man as observed in a small series in the dissecting laboratory: H. C. DANFORTH. (By title.)

Utilization of dissecting room material for the study of physical anthropology: R. T. FERRY. (By title.)

On certain variations in the form of the human scapula: W. W. GRAVES. A large collection of scapulas, both of man and of animals, were shown by specimens and on the screen. Variations of many sorts were pointed out.

The occipital (supra-inionic) forsa, and its true significance: A. HRDLIČKA. (By title.)

Theories of sternal origin: F. B. HANSON. By title.)

The St. Louis group of mounds: H. M. WHELPLEY. St. Louis became known as the "Mound City," early in the nineteenth century. This was due to a group of twenty-seven mounds on the Mississippi River bank, near what is now the business center of the city. As early as 1819, Major Stephen H. Long made what was probably the first map of the mound group. The twenty-six smaller mounds were destroyed before 1850. The remaining "Big Mound," which was one hundred and fifty feet long and about thirty feet high, was removed in March and April, 1869. Professor Spencer Smith had recently read a paper before the Academy of Science of St. Louis in which he gave seemingly convincing evidence that the mound was a natural formation. This prevented the local universities and scientific organizations from taking an interest in the demolition of the mound. A local artist, A. J. Conant, a photographer, Thomas M. Easterly, and the editor of the Missouri *Democrat,* seem to have been the only ones who followed the destruction of the mound with scientific interest. Conant was present daily. The Missouri *Democrat* describes the excitement caused when the workmen found at the base of the mound a sepulcher over seventy-four feet long, twelve feet wide and several feet high. It contained many human skeletons and a large quantity of shell beads. The editor said: "This stunned the zealous advocates of the natural formation theory." The paper was illustrated with a series of slides made from daguerreotypes, taken by Mr. Easterly, showing successive stages of the work of demolition of the mound.

Notched flint hoes of St. Louis and vicinity: H. M. WHELPLEY. The flint agricultural implements of the pre-Columbian Indians are designated as "spades and hoes." The spades are so called because they somewhat resemble in shape the blade of a modern iron spade. There is no evidence, whatever, that these blades of flint were ever hafted like our spades of to-day or employed as we use spades. The word "spade" is a misnomer. All flint agricultural implements should be termed "hoes." The hoes are divided into notched and unnotched. The notched hoes form but a small per cent. of the total number of flint hoes. They are distributed over a much more restricted area than the unnotched form of hoes. Flint hoes in general are found over a small section of the Mississippi Valley. The author proposes fourteen terms to designate the various parts of a notched hoe. Six points were considered under "Standard of Perfection." The term "flint" is used in the popular sense. Nearly all of the notched hoes are made from Union county, Illinois, chert. A few are of novaculite, quarried by the Indians in the same county. Occasionally, specimens were made from "Alton flint," from bluish flint balls, and perhaps from St. Louis county flint. The usual type of notched hoe is oval but some are triangular and a few rectangular. The influence of material on type was discussed and the evolution of the notched from the unnotched shown by a long series of successive stages of evolution. Attention was given the probable methods of manufacture. The author has for forty years studied the quarries and work-shops. The finest implements are found in St. Clair and Madison counties, Ill., far from the

quarries. Few hoes occur west of the Mississippi River. The gradation of notched hoes into axes, hammers and other artifacts was demonstrated. This paper was based on the study of several hundred specimens in the collection of the author.

Notes on the sitting height in man: R. B. Bean. (By title.)

Clinical study as a type of experimental education: F. N. Freeman. Psychological research in the field of learning has in recent years consisted largely of mass studies or studies of groups of individuals. For example, a common method is to compare the effectiveness of two methods of learning by comparing the average score made by a group which pursues one method with the average score obtained by the other method. These averages often conceal important variations from the rule in the case of individuals. It is necessary to make analysis of the factors involved in such cases if the laws of learning are to be completely understood. The clinical study of a child afflicted with congenital word-blindness illustrates such an analysis. The case was diagnosed as hopeless by a well-known oculist. Difficulty with reading was reported in the case of two near relatives. The Binet test and several specialized tests revealed no defect other than the inability to read. Photographs of the eye movements in reading showed serious lack of coordination. In spite of four years of schooling the child had less than median first-grade reading ability. Forty minutes training a day, in which phonics were abandoned and direct practise in comprehension together with the prevention of attention wandering and eye wandering were emphasized, resulted at the end of ten weeks in better than third-grade reading ability and in much better coordinated eye movements.

The concept of feeble-minded, especially the moron: J. E. W. Wallin. Feeble-mindedness is not primarily a medical or psychological concept, but a socio-legal concept, referring to a condition of social and industrial dependency due to intelligence defectiveness dating from birth or from early life, and should only be used in this sense. The practise has been very widely followed of considering that the highest grade of feeble-minded persons develops to an intelligence level of twelve years. The writer's conclusion, based on the individual examination of thousands of subjects, is in complete agreement with the finding of the division of psychology in the army that the highest grades of mental defectives, the so-called morons, do not develop beyond an intelligence level of nine years, and that some persons who stagnate at the ninth-year level can not be considered feeble-minded. On the basis of the 70 I.Q. standard of feeble-mindedness, and the average intelligence age of the selective service men, the highest intelligence level reached by the feeble-minded would be 9.2 years. These findings necessitate the complete rejection of the concept of the "middle" and "high-grade morons," and a considerable lowering of the borderland region. The borderland region probably must be placed between the upper limit of age seven and the upper limit of age nine or at most ten (by the Stanford scale), instead of between ages ten and twelve. In other words, persons who reach an intelligence level of ten years should be classified as borderland, backward or dull. The gradual appreciation of the above facts has recently led to the proposal that the concept of feeble-mindedness be extended beyond its traditional connotation of intelligence deficiency, so as to include individuals who are emotionally, temperamentally or volitionally defective or unstable, even though they may be normal in intelligence. This extension is unacceptable. Such individuals can not be considered feeble-minded unless they are sufficiently intellectually deficient to be so regarded, but must be classified otherwise. The term defective delinquents is suggested for emotionally or temperamentally unstable delinquents who are in need of restraint or special care and who are of borderline, backward or normal intelligence—and thus not feeble-minded—and who can not be placed in a definite, clear-cut classification, such as psychotic, psychopathic, neurotic, hysterical, choreic or epileptic.

(To be concluded)

Edward K. Strong,
Secretary

SCIENCE

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